Ent. Dept.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine
Division of Fruit Insect Investigations

University of California — Hawaii Agricultural Experiment Station

Territorial Board of Agriculture and Forestry

Pineapple Research Institute — Hawaiian Sugar Planters' Association Experiment Station.

INVESTIGATIONS OF FRUIT FLIES IN HAWAII
(Formerly Oriental Fruit Fly Investigations.)

QUARTERLY REPORT

April 1 - June 30, 1952.

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WORK PROJECT I-o-5 - COMMODITY TREATMENTS - J. W. Balock, Project Leader

SUMMARY

Line Projects I-o-5-1, I-o-5-2, I-o-5-3, I-o-5-5, and I-o-5-6 INACTIVE.

Fumigant Screening

Thirty-five materials were screened as fumigants against naked eggs and larvae of D. dorsalis. Three compounds, epibromohydrin, epichlorohydrin and 2-bromo ethanol killed all eggs and larvae at less than 2 milliliters per liter. The most effective, epibromohydrin, killed 95% of both eggs and larvae at 9 milligrams per liter. Two materials, n-butyl amine and 1,2-dibromo ethylene killed 95% of the eggs at 12.5 mgs./liter and 70 mg./liter, respectively, but were ineffective against the larvae. Seven compounds were effective against larvae at rather large dosages (22 to 65 mgs. per liter) but were ineffective against the eggs.

Tests With EDB.

Pupae of D. dorsalis, D. cucurbitae, and C. capitata were fumigated with EDB for two hours at 70° F.. Susceptibility was in the order named; LD-95 was attained at approximately 0.62, 1.00, and 1.13 milligrams per liter, respectively. At the highest dosage used, 1.33 mgs. per liter, only capitata pupae developed a few adults.

Naked eggs and larvae of D. dorsalis were fumigated with EDB, 1.1 mgs. per liter at 75° F., for varying intervals. Larval mortality was greater than egg mortality at exposures of 1 hour or less. At 2 hours, egg and larval mortalities varied from 87 to 99.5%; at 4 hours, from 98 to 100%.

Tests with varying fruit loads equal to from 1/4 to 3/4 the free space in the chamber showed that with a 1:4 ratio of fruit volume to fumigating space a dosage of 2 mg./liter was sufficient to cause complete fruit fly mortality; more than 4.0 mg./liter were necessary with fruit volume ratios of 1 to 2 and 3 to 4.

Results of tests conducted with papayas packed in sealed cardboard containers and fumigated with ethylene dibromide in a 10 cu. ft. chamber showed survivors at 5 mg./liter and none at 7 and 8 mg./liter. In tests with fruits packed in paper excelsior in open wooden crates fruit fly survival was recorded at 6 mg./liter but none at higher dosages.

Relative amounts of EDB sorbed after 2 hours by various materials during fumigation at 1/2 lb./1000 cu. ft. were as follows:

Material	Per cent of EDB sorbed
Empty metal chamber (10 cu. ft.)	53
8 wooden crates	28
8 cardboard cartons + wood excelsior	40
8 " " + cardboard partitions	43
120 papayas	3

Fumigation with EDB on oranges infested by Medfly in cages resulted in survivals at 1/4 lb./1000 cu. ft. for 2 hours at 70° F. but no survival at 3/8 and 1/2 lb. with low fruit fly populations.

Tolerance was determined of pineapple and papaya fumigated with EDB at 3/4 and 1.0 lb./1000 cu. ft. for 2 hours at 70° F. in sealed cardboard cartons. Following fumigation, the fruits were stored at 55° F. together with unfumigated fruits under similar conditions. No differences between check fruits and fumigated fruits could be determined.

WORK PROJECT I-c-5. - COMMODITY TREATMENTS - J. W. Balock, Project Leader

Line Projects I-c-5-1, I-c-5-2, I-c-5-3, INACTIVE.

Line Project I-c-5-4. To Test New and Previously Untried Fumigants for Use in Commodity Treatments. (Balock, Hinman, Kozuma)

1.--Fumigant Screening. (Hinman):

Thirty-five materials were screened as fumigants against naked eggs and third-instar larvae. A total of 215 compounds have been tested to date. The results are shown in table 1.

Three materials killed all eggs and larvae at dosages of less than 2 milliliters per liter. These materials were epibromohydrin, epichlorohydrin, and 2-bromo ethanol. All three were more effective against larvae than against eggs, killing 95% of the larvae at less than 10 mgs. per liter and 95% of the eggs at 8.9, 24, and 53 mgs. per liter, respectively.

Both epibromohydrin and 2-bromo ethanol were about equally as effective against the larvae as the corresponding chloro compounds and both were more effective against the eggs than the corresponding chloro materials. 2-chloro ethanol had previously been found to kill 95% of the larvae at 11.5 mgs./liter and less than 95% of the eggs at 100 mgs./liter.

Two materials were effective against eggs but not against larvae: n-butyl amine (95% mortality at 12.5 mgs./liter) and 1,2-dibromo ethylene (95% mortality at 70 mgs./liter).

Seven materials were effective against the larvae but not against the eggs. These materials killed 95% of the larvae at from 22 to 65 milligrams per liter.

Tests of EDB Against Pupae of Three Fruit Fly Species. (Hinman):

Pupae of different ages obtained from the rearing laboratory and reared on the standard rearing medium were fumigated with EDB in 5-gallon cans. Two per cent EDB in CCl_4 was used at 6 different dilutions, from 0.22 to 1.33 milligrams of EDB per liter. The pupae were counted into vials, 25 in each vial, and fumigated at 70° F. for two hours. The results of two tests are presented here although Test 1 was conducted during a previous quarter.

The results are shown in table 2. The average combined mortalities are graphed in figure 1. The average results with each species in each of the two tests are shown in figure 2.

Each species reacted differently: D. dorsalis pupae were the most easily killed; C. capitata pupae were the most resistant. The points of 50%, 95%, and 98% mortality were approximately as follows:

	D. dorsalis	D. cucurbitae	C. capitata
LD-50	0.27 mgs./L	0.70 mg./L	0.80 mg./L
LD-95	0.62 "	1.00 "	1.13 "
LD-98	0.80 "	1.10 "	1.25 "

Table 1.--Materials screened as fumigants against naked eggs and third-instar larvae of Dacus dorsalis.

MATERIALS	Eggs		Larvae				Mortalities (%) at highest dosage tested (0.1025 mls. per liter; approx. 3/4 gal. per 1000 cu. ft.)	
			24 hours		48 hours			
	LD-50 Mg./L	LD-95 Mg./L	LD-50 Mg./L	LD-95 Mg./L	LD-50 Mg./L	LD-95 Mg./L	Eggs	Larvae (after 48 hours)
HALOGEN COMPOUNDS								
Bromides								
1,2-dibromo ethylene	45	70	>232	>232	210	>232	100	61
1,2-dibromo-2-methyl propane	>180	>180	49	>180	33	130	0	97
2,3-dibromo butane	>170	>170	4.5	>170	3.3	>170	22	88
2,4-dibromo pentane	>156	>156	>156	>156	>156	>156	13	48
1,5-dibromo pentane	3.2	>174	>174	>174	>174	>174	64	17
2,5-dibromo hexane	>150	>150	>150	>150	>150	>150	0	7
2,5-dibromo toluene	>191	>191	>191	>191	>191	>191	0	1
Chlorides								
Pentachloro ethane	>171	>171	43	>171	16	60	12	100
n-propyl chloride	>91	>91	>91	>91	>91	>91	3	16
2,2-dichloro propane	>112	>112	>112	>112	>112	>112	11	48
1,1,2,3-tetrachloro propane	>170	>170	>170	>170	75	>170	39	54
1,2,2,3-tetrachloro propane	>142	>142	100	>142	85	>142	0	74
1,1,3,3-tetrachloro propene	>147	>147	5	>147	2.2	10	42	100
s-butyl chloride	>89	>89	>89	>89	>89	>89	15	12
i-amyl chloride	>91	>91	>91	>91	>91	>91	5	8
t-amyl chloride	>89	>89	>89	>89	>89	>89	11	7
n-octyl chloride	>89	>89	>89	>89	>89	>89	6	0
cyclopentyl chloride	>95	>95	9	31	5.5	24	7	100
1,2-dichloro-2-fluoro propane	>129	>129	46	63	40	52	22	100

Table 1 (cont'd)

MATERIALS	Eggs		Larvae				Mortalities (%) at highest dosage tested (0.1025 mls. per liter; approx. 3/4 gal. per 1000 cu. ft.)	
			24 hours		48 hours			
	LD-50 Mg./L	LD-95 Mg./L	LD-50 Mg./L	LD-95 Mg./L	LD-50 Mg./L	LD-95 Mg./L	Eggs	Larvae (after 48 hours)
HALOGEN SUBSTITUTION COMPOUNDS								
Bromal ($CH_2Br-CHO$)	>235	>235	>235	>235	>235	>235	1	47
2-Bromo ethanol (CH_2Br-CH_2OH)	20	53	5.6	9.5	5.4	9.0	100	100
Epibromohydrin ($OCH_2-CH-CH_2Br$)	4.7	8.9	3.1	5.2	2.3	4.0	100	100
Epichlorohydrin ($OCH_2-CH-CH_2Cl$)	15	24	2	3.8	1.9	3.5	100	100
Acetyl chloride (CH_3-COCl)	>113	>113	33	80	26	65	28	100
Propionyl bromide (CH_3-CH_2-COBr)	>155	>155	>155	>155	>155	>155	0	13
Propionyl chloride (CH_3-CH_2-COCl)	>109	>109	>109	>109	>109	>109	9	33
COMPOUNDS OTHER THAN HALOGENS								
Propionaldehyde (CH_3-CH_2CHO)	58	100	19	44	16	38	91	100
Paraldehyde ($OCH(CH_3)OCH(CH_3)OCH(CH_3)$)	>101	>101	>101	>101	>101	>101	0	6
Diacetyl ($CH_3CO-COCH_3$)	>101	>101	>101	>101	73	>101	8	74
Propiophenone ($C_6H_5COCH_2-CH_3$)	>103	>103	>103	>103	>103	>103	32	3
Ethyl acetate ($CH_3-COOC_2H_5$)	>92	>92	>92	>92	>92	>92	8	26
Ethyl propionate ($CH_3-CH_2-COOC_2H_5$)	>90	>90	>90	>90	>90	>90	8	0
n-butyl amine ($CH_3-CH_2-CH_2-CH_2NH_2$)	8.3	12.5	34	>76	23	>76	100	94
Acetic acid (CH_3-COOH)	>107	>107	39	61	36	56	2	100

Table 2.--Emergence of flies from pupae fumigated with EDB (2% in CCl_4). Emergence (per cent) in comparison with emergence from unfumigated checks as 100%.

Milligrams of EDB per liter	Test	Dacus cucurbitae						Dacus dorsalis						Ceratitis capitata					
		Age when fumigated (days)						Age when fumigated (days)						Age when fumigated (days)					
		1	3	5	7	8	Ave.	1	4	5	7	8	Ave.	1	4	5	7	8	Ave.
		% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck	% of ck
0.22	1	70			254	122		108	73			40		44.4	101.8			100	
	2	233*	75	71			132	40		62	39		60	85		102	97*		88
0.45	1	32			91	—		48	49			—		18.5	96.4			—	
	2	67	100*	77			73	10		21	8		23	84		92	84		75
0.67	1	25			91	8.5		83	90			57		0	96.4			76.7	
	2	33	25*	17			29.5	2		3	4		53	30		77	73		59
0.89	1	0			27	0		0	0			0		0	25.5			7	
	2	67	12	28			22	1		4*	2		1.1	28		46	69		29
1.11	1	0			9.1	2.7		0	0			0		0	3.6			11	
	2	22	0	17			8.5	0		0*	0		0	8		18	23		10.6
1.33	1	0			0	0		0	0			0		0	1.8			0	
	2	0	0	0			0	0		0*	0		0	2		3	0		1.1
Pupae fumigated at each dosage (Number)	1	75			75	75		75	150			75		75	75			75	
	2	150	150	150				150		150	150			150		150	150		
Emergence from control pupae untreated** (Per cent)	1	80			15	49		96	96			93		54	73			57	
	2	6	16	12				64		83	88			65		78	90		

* Only 100-125 pupae fumigated.
** Test 1 - 75 pupae in each control. Test 2 - 150 pupae in each control.

Figure 1.—Mortalities of pupae of three species of fruit flies with different dosages of EDB (using 2% EDB in CCl_4). Two hours' exposure at 70° F.

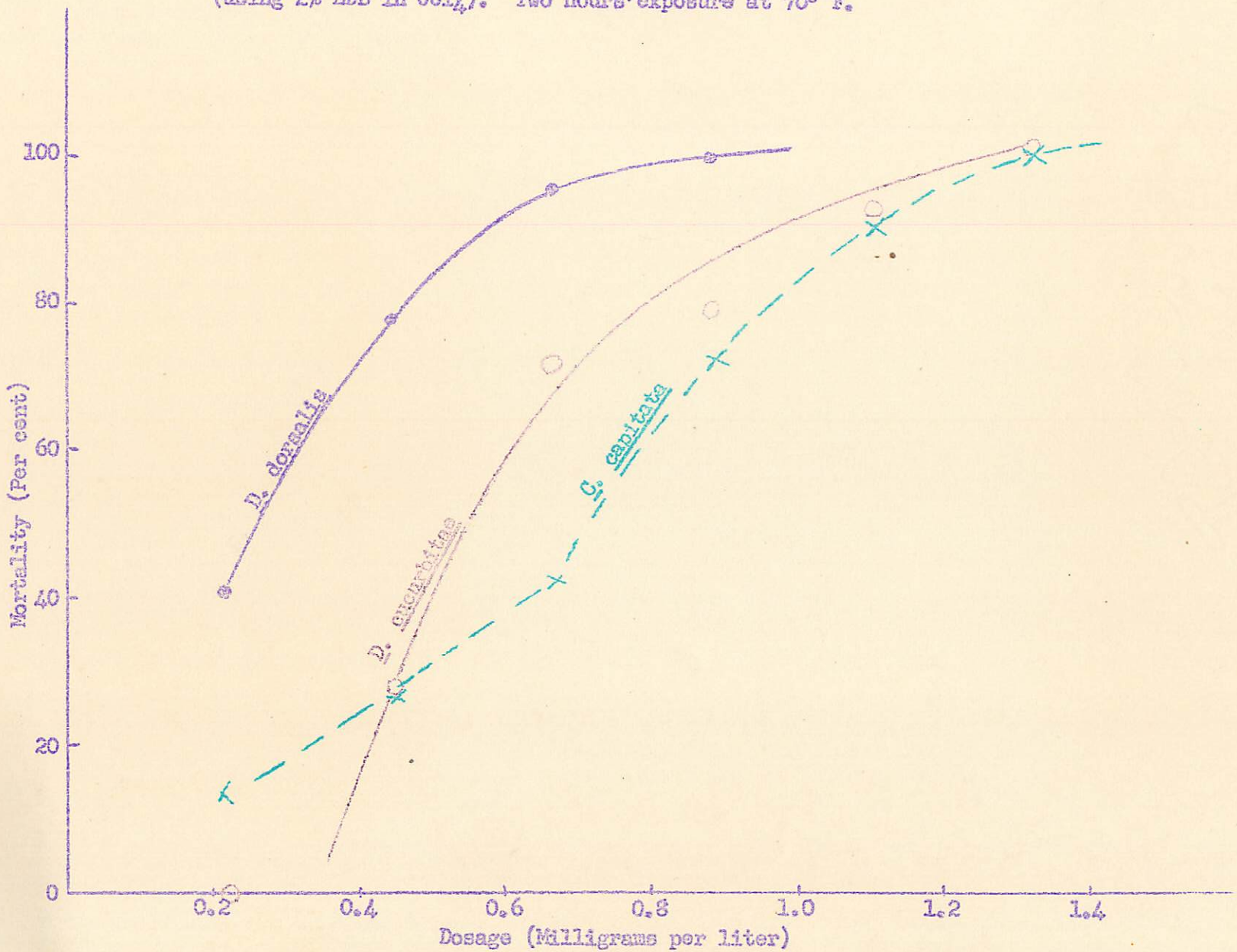
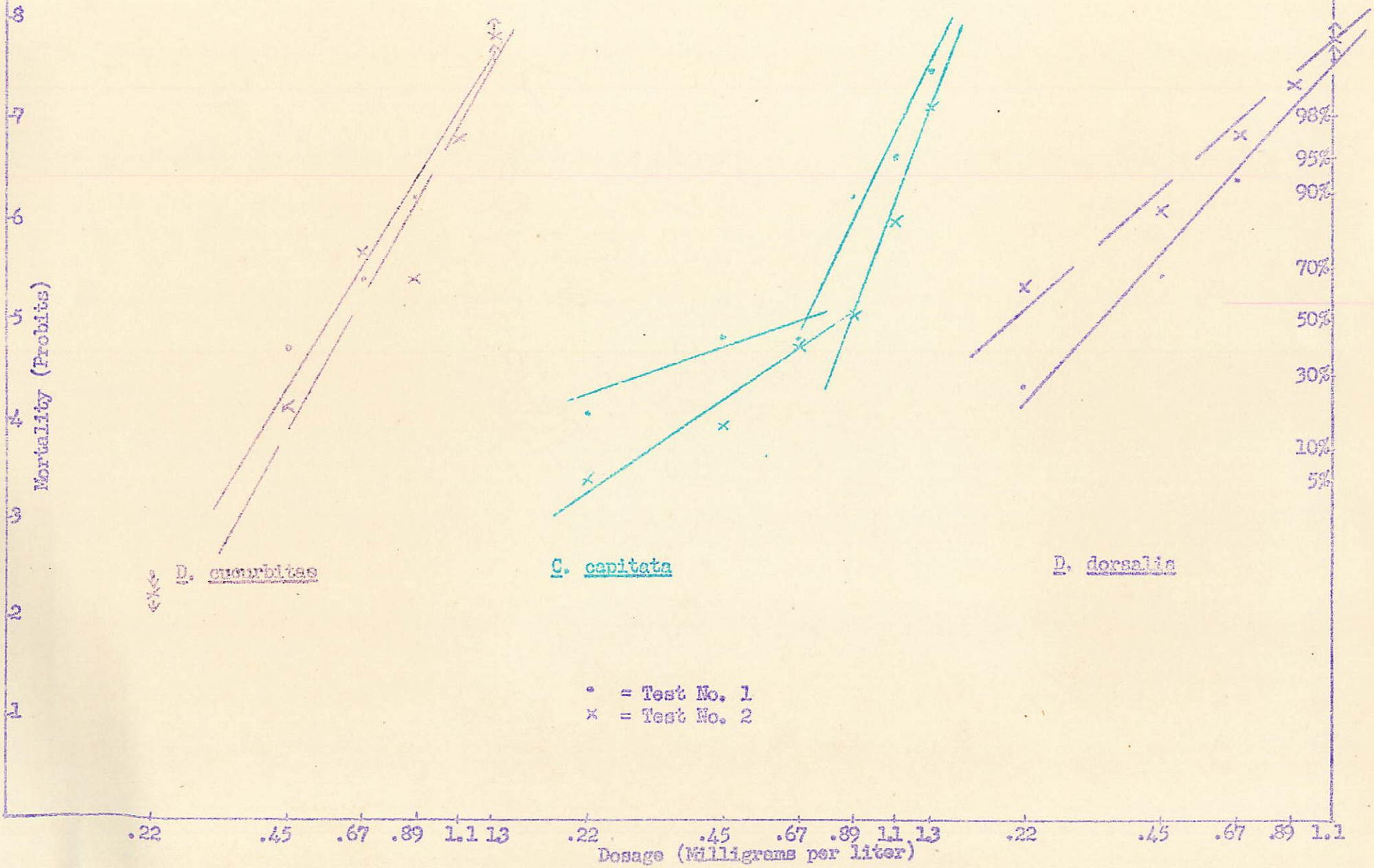


Figure 2.--Mortalities of pupae of three species of fruit flies fumigated with EDB. Two hours' exposure at 70° F.



At the highest dosage, 1.33 mg./liter, a few flies emerged from the capitata pupae, but no flies emerged from the pupae of the other two species.

It is interesting that the relative resistance of dorsalis and cucurbitae is the reverse in the egg and larval stages. Balock found cucurbitae eggs and cucurbitae in infested fruits to be more easily killed than dorsalis eggs or dorsalis in infested fruits (Quarterly Report Oct.-Nov., 1951, p. 203, and Quarterly Report Jan.-Mar., 1951, p. 629).

No consistent relationship was found between mortalities and the ages of the pupae at the time they were fumigated.

Effect of Length of EDB Exposure Period On Eggs and Larvae of D. dorsalis (Hinman):

Naked eggs and third-instar larvae of D. dorsalis were fumigated for varying intervals in 5-gallon cans, using 10% EDB in CCl_4 at a dosage of 1.1 milligrams of EDB per liter and at a temperature of 74-75° F. The results are shown in figure 3 and in the table below.

	Average mortalities (per cent) 48 hours after fumigation				
	Fumigation period				
Test	15 min.	30 min.	1 hour	2 hours	4 hours
EGGS (4 lots of 100 in each test)					
1	16	9	66	87	98
2	2	14	52	90	100
LARVAE (4 lots of 50 in each test)					
1	87	97	98	99.5	100
2	19	46	67	88	98

At exposures of 1 hour or less, larval mortalities were greater than egg mortalities in both tests. At 2 and 4 hours, differences, if they existed, could not be determined.

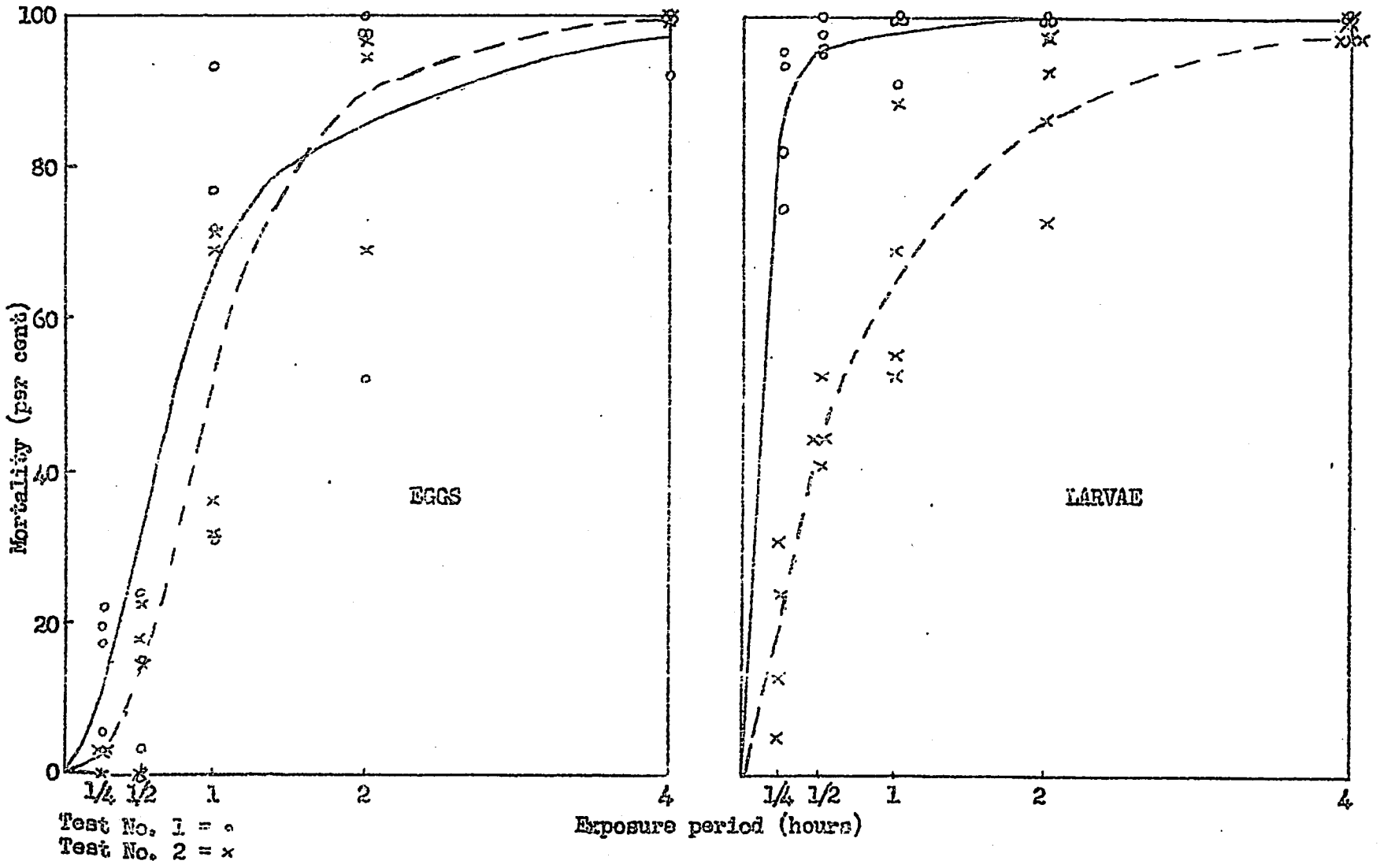
The larvae used in the first test were fumigated immediately after they were washed from the carrot media; the larvae used in the second test were washed out and put with freshly ground carrots and Eutoben (one of the ingredients in the carrot media rearing mixture) 24 hours before they were rewashed and used in the tests. Perhaps this difference in treatment may explain, in part, the considerable difference between the two tests in the larval mortalities.

2.--Tests with Ethylene Dibromide (Balock)

This work will be discussed under the following general headings:

A.--Equipment
B.--Fruit Load and Its Relation to Effectiveness of EDB.
C.--The Use of Excelsior for Packing and Its Effect on Fumigation with EDB.
D.--Fumigation with EDB in Sealed Cardboard Cartons.
E.--Chemical Analysis of EDB During Fumigation.
F.--Biological Measurements of EDB.
G.--EDB As a Fumigant for the Mediterranean Fruit Fly in Oranges.
H.--Tolerance Studies.

Figure 3.—Effect of length of EDB exposure period upon eggs and larvae of D. dorsalis (1.1 mg./L. at 70° F.).



A.--Equipment: The equipment used in these studies in the past has been a 240 cu. ft. sheet metal lined chamber equipped with temperature control by either heating or cooling. Circulation of gas has been provided by means of a standard air conditioning unit moving approximately 125 cu. ft. of air per minute. The fumigant was applied as a liquid into a 4" porcelain crucible and heated over a hot plate. Time for vaporization was 8 to 12 minutes and was included in the exposure time.

Studies have also been conducted in four 7.7 cu. ft. steel drums with water-seal lids. Gas circulation has been provided by an 8" fan located at the bottom of the drum. The fruit was stacked on a 7" high stand directly over the fan. The fumigant was measured as a liquid in a burette graduated to .05 ml., and applied through a small opening in the lid onto a heated 4" porcelain crucible placed a few inches below the lid. The opening was sealed immediately with no apparent loss of gas.

Two 10 cu. ft. rectangular chambers, 20" x 24" x 36" high, constructed of 16 gauge sheet metal, were recently constructed and substituted for the above drums in more recent tests because rectangular chambers are better adapted for loading standard containers than round ones. These chambers were also equipped with a water-seal lid, a very desirable feature where rapid closing and an absolutely gas-tight seal is required. One-half and 3/4-inch pipe fittings in the lid and sides of the chamber provided openings for electric wiring, gas sampling and for introducing the fumigant. The fumigant was applied as in the steel drums.

Bids have been accepted for the construction of a new chamber of 100 cu. ft. capacity with 16 gauge inner sheet metal lining, insulated and equipped with heating and cooling units and temperature control between 60 and 90° F. The 240 cu. ft. chamber which has been subjected to heavy usage is also being renovated.

When work is completed, we shall have chambers of 10, 100, and 240 cu. ft. capacity. An important factor in fumigation is the relationship of fruit load to free air space in the chamber, and in order to develop sound data that may be applied to commercial conditions it is essential to obtain mortality data with comparable load-free air space ratios. One other factor about which information is needed is gas distribution in rooms of various sizes with comparable fruit loads. Gas distributions determined chemically and biologically can be compared in these 3 chambers and this information will be useful in determining requirements for commercial rooms.

Five gallon (19.6 liter) friction-top tins have also been used to some extent in the past for EDB studies. Although very useful for fumigant screening studies, these containers are believed to be too small for accurate determinations where mortality studies in fruit are involved, and their use in the future will be restricted to fumigant screening.

B.--Fruit Load and Its Relation to Effectiveness of EDB: These tests were conducted in two 7.7 cu. ft. drums with water-seal lids. The purpose was to determine how an increase in fruit load would effect fruit fly mortality after fumigation with EDB. The fruits were loaded into the drums loosely, without any containers, over a 7" stand, and continuous circulation of air was maintained from below by means of an 8" fan. The EDB was applied as a liquid from a burette graduated to .05 ml. into a very hot porcelain

crucible of 4" diameter placed directly under a small opening in the lid which was immediately closed with a rubber stopper. Although vaporization of EDB by this method was very rapid, there was little, if any, gas loss through the opening for the burette because of the speed of operation.

The fruit loads tested were 55 papayas occupying a volume equal approximately to 1/4 that of the free air space in the drum, 110 and 120 equal to 1/2, and 165 fruits equal to 3/4 of the free air space.

Fifteen experiments were conducted at dosages from 1 to 4 mg./liter equivalent to 1/16 to 1/4 lb./1000 cu. ft. The data were insufficient for constructing mortality curves, but it was quite evident that survival increases somewhat with an increase in fruit load. The results are summarized in table 3.

Table 3.--Ratio of fruit volume to fumigating space and its relation to oriental fruit fly mortality in papayas fumigated with EDB at various dosages for 2 hours at 70° F.

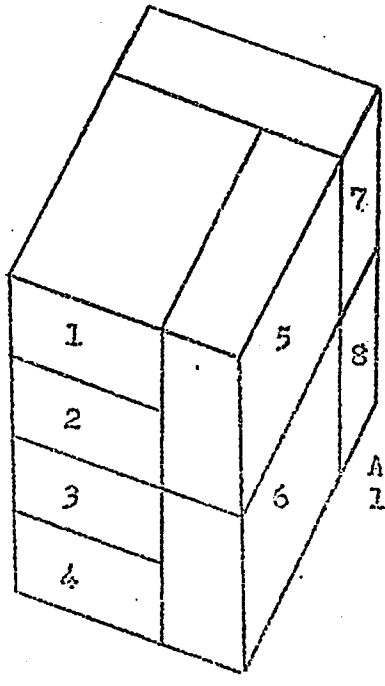
Ratio of fruit volume to fumigating space	No. of tests	Dosage mg./l.	Estimated fruit fly population	No. of survivors	Per cent mortality
1:4	2	1.0	4,680	234	95.0
	1	1.5	978	35	96.42
	1	2.0	1,928	0	100.0
	2	4.0	3,841	0	100.0
1:2	1	1.0	3,825	437	88.57
	1	1.5	1,956	62	96.83
	1	2.0	3,856	19	99.50
	3	4.0	9,578	3	99.97
3:4	1	1.5	2,934	242	91.75
	2	4.0	16,600	17	99.90
Totals	15		50,176		

C.--<u>The Use of Excelsior for Packing and Its Effect on Fumigation with EDB</u>: The use of paper excelsior or any packing material during fumigation with EDB is restricted because it has been found that under such conditions mortality is reduced. The tests reported here were conducted to determine how much the effectiveness of fumigation is reduced when paper excelsior is used for packing.

These experiments were conducted in a 10 cu. ft. chamber with a water-seal lid made of 16 gauge sheet metal, riveted and soldered at all joints. The fruit load for all tests was maintained constant at 120 papayas packed in 8 wooden crates (6 1/2 x 11 x 19") with slatted openings on all sides and on the bottom (Fig. 4). Tests were run with papayas packed with and without paper excelsior and the mortality of the immature stages of the oriental fruit fly in the fruit were compared. Dosages tested were in the range of 1 to 8 mg./liter (1/16 to 1/2 lb./1000 cu. ft.). The results from 12 paired tests are shown in table 4. Mortalities in naked fruits were consistently higher than those in excelsior packed fruits as was expected but the differences were small in most instances. With naked fruits complete mortality was recorded at dosages of 6 mg./liter and above. With excelsior packed fruits the lowest dosage producing 100 per cent kill was 7 mg./liter.

Fig. 4. Ten cu. ft. sheet metal fumigation chamber showing stand, fan, and fruit trays with papayas packed in paper excelsior for test with EDB.

D.--Fumigation with EDB in Sealed Cardboard Cartons: Twenty-two tests were conducted to determine the feasibility of fumigating commodities packed and sealed ready for shipment in cardboard shipping containers, 6 1/2" x 11" x 16". The effect under two methods of packing was tested. Under one method papayas were packed 8 to a carton with each fruit separated by cardboard sections. Under the other method the papayas were wrapped individually in citrus tissue and packed in wood excelsior. This is illustrated in figures 5 and 6. Eight cartons were fumigated at one time in a 10 cu. ft. galvanized sheet metal chamber, 20 x 24 x 36", with an inside volume of 10 cu. ft. The cartons occupied approximately 5.3 cu. ft. and were stacked in 3 stacks of 4, 2, 2 cartons without separation between boxes in the same stack. (See diagram.) In most tests naked eggs on wet blotting paper in Petri dishes, 100 eggs to a Petri dish, were put inside the sealed cartons. Usually the eggs were placed in cartons at the top and bottom of the chamber and in some cases a third dish of eggs was inserted in a carton at the approximate center. Eggs were removed from the cartons 1 to 6 hours after fumigation; then the cartons were resealed and allowed to stand 24 hours before the fruit was removed and placed in holding boxes to determine fruit fly survival.



Arrangement of cartons in 10 cu. ft. chamber.

The data are presented in table 4. Detailed data for all experiments are listed chronologically in table 5.

The results are very encouraging for the fumigation of sealed cartons. There are surprisingly small differences in fruit fly mortality in fruits packed in sealed cartons as compared to fruits in open wooden crates. In fact the mortality was highest in sealed cartons with excelsior pack where survivors were recorded at only 2 mg./liter (1/8 lb./1000 cu. ft.) and none at the higher dosages of 4 to 12 mg./liter (1/4 to 3/4 lb./1000 cu. ft.).

With fruits fumigated in open wooden crates without any packing, survivors were recorded at 5 mg./liter and none at 7 and 8 mg./liter. Where fruits were packed with paper excelsior, survival was extended to 6 mg. but mortalities were complete at 7 and 8 mg./liter. In experiments with papayas sealed into paper cartons with cardboard separators between fruits and only 8 fruits per carton mortality was initially high (98.9%) at 2 mg./liter but survivors were recorded at 4, 6, and 10 mg./liter and none at 8 or 12 mg./liter. Since gas analyses have indicated that adsorption under both methods of packing in sealed cartons is essentially similar, it would appear that the cardboard separators are interfering more with gas movement than is the excelsior. It is also possible, since fruits are retained in sealed cartons for 24 hours after fumigation, that more of the gas is retained in the cartons containing excelsior, resulting in a greater post-fumigation effect.

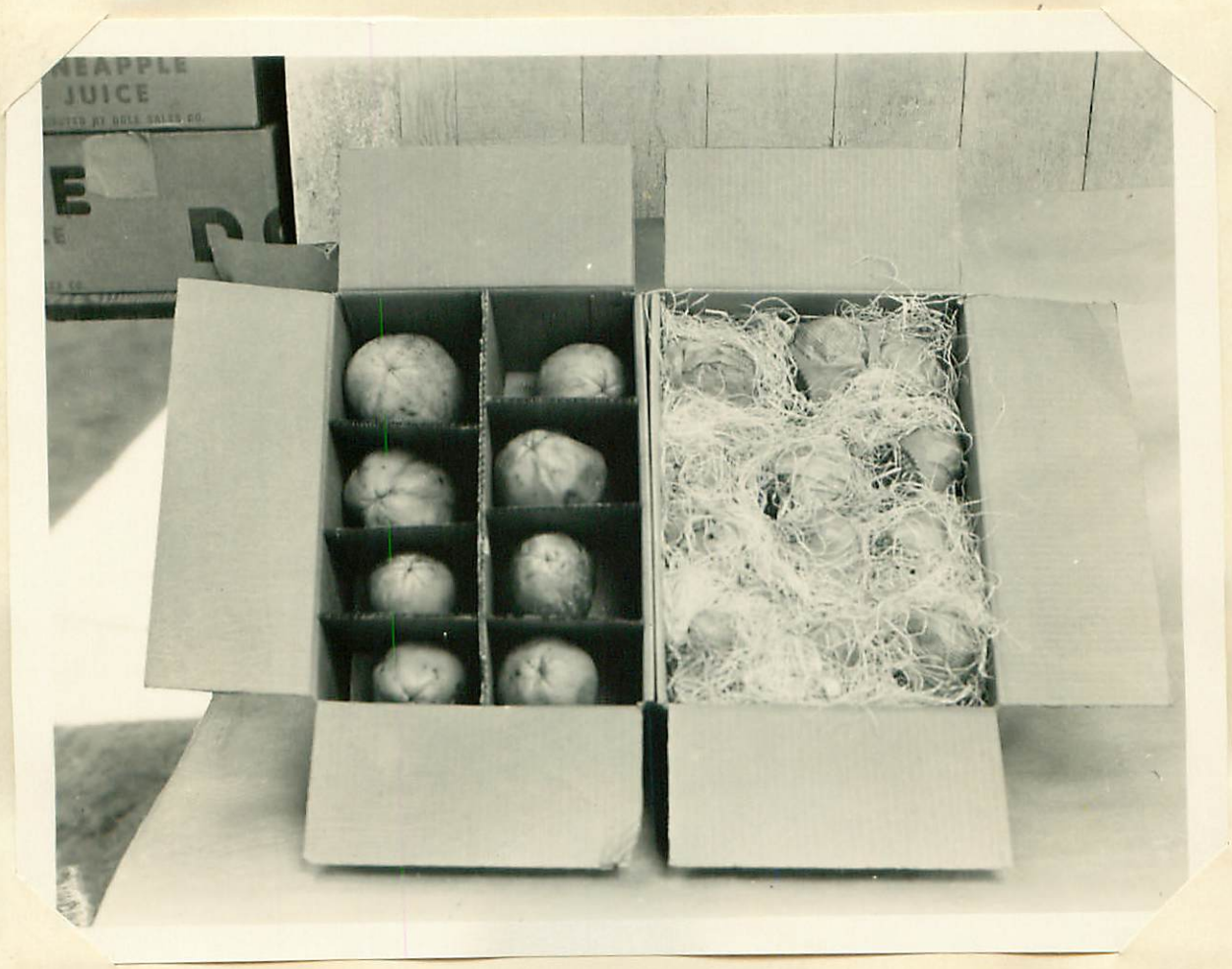


Fig. 5.—Two methods of packing papayas for fumigation tests with EDB. At left, fruits packed with cardboard sections. At right, fruits wrapped in citrus tissue and packed in wood excelsior. Top layer of excelsior has been removed to show fruits.

Fig. 6.--Sealed carton containing papayas used in fumigation tests.

Table 4.--Mortality of the immature stages of the oriental fruit fly in papayas packed with and without excelsior in open wooden crates and sealed paper cartons and fumigated with EDB at dosages from 1 to 12 mg./l. (1/16 to 3/4 lb./1000 cu. ft.) for 2 hours at 70° F. in a 10 cu. ft. sheet metal chamber.

Dosage mg./l.	8 wooden crates with 15 papayas each--- (no packing material)			8 wooden crates with 15 papayas each--- (paper excelsior pack)			8 sealed cardboard cartons with 8 papayas each and cardboard separator pack.			8 sealed cardboard cartons with 10-12 papayas ea. in citrus wrap & wood excelsior pack.		
	Est. pop.	No. surv.	% mort.	Est. pop.	No. surv.	% mort.	Est. pop.	No. surv.	% mort.	Est. pop.	No. surv.	% mort.
1.0	3825	1598	58.2	3825	1801	52.9	---			---		
2.0	3856	222	94.2 } 94.4	3856	2589	32.9 } 35.1	1915	21	98.9	2393	3	99.9
2.0	132	0	100.0 }	132	0	100.0 }						
3.0	958	1	99.9	958	29	97.0	---			---		
4.0	3825	0	100.0 } 99.0	3825	166	95.7 } 87.2	1904	6	99.7 } 99.7	2378	0	100.0
4.0	3856	78	98.0 }	3856	817	78.8 }	383	0	100.0 }	575	0	100.0
5.0	958	4	99.6	958	7	99.3	---			---		
6.0	132	0	100.0	132	4	97.0 } 99.4	383	0	100.0 } 99.8	575	0	100.0
6.0	549	0	100.0	549	0	100.0 }	1915	4	99.8 }	2393	0	100.0
7.0	958	0	100.0	958	0	100.0	---			---		
7.0	549	0	100.0	549	0	100.0	---					
8.0	132	0	100.0	132	0	100.0	383	0	100.0	575	0	100.0
8.0							14	0	100.0	17	0	100.0
8.0							1904	0	100.0	2380	0	100.0
10.0							1915	21	98.9	2393	0	100.0
12.0							14	0	100.0	17	0	100.0
12.0							1904	0	100.0	2380	0	100.0

Table 5.—Mortality of the immature stages of the oriental fruit fly in papayas fumigated for 2 hours at 70° F. with ethylene dibromide at various dosages and under varying loads and methods of pack.

Expt. No.	Type of fumigator	Dosage mg/l	Dosage lbs./1000 ft.³	Method of Loading	No. of fruits	Estimated population	Survivors pupae	Survivors adults	Per cent mortality	Per cent mortality naked eggs	EDB recovered 2 hrs. mg/l
226	7.7 cu.ft. drum	1.5	3/32	Loose—no containers	55	978	35	1	96.42	100.0	
227	"	1.5	"	" " "	165	2,934	242	124	91.75	98.79 100.0	
228	"	1.5	"	" " "	110	1,956	62	24	96.83	100.0 100.0	
229	"	1.0	1/16	" " "	55	2,767	152	70	94.51	85.7 82.9	
230	"	4.0	1/4	" " "	165	8,300	7	4	99.92	100.0	
231	"	4.0	"	" " "	165	8,300	10	0	99.88	100.0	
232	10 cu.ft. chamber	2.0	1/8	Excelsior pack in 8 wooden crates.	120	3,856	2589	1659(11)	32.86	—	
233	"	2.0	"	Fruit naked in 8 wooden crates.	120	3,856	222	135	94.24	—	
234	7.7 cu.ft. drum	2.0	"	Loose—no containers	60	1,928	0	0	100.0		
235	"	2.0	"	" " "	120	3,856	19	14	99.50		
236	10 cu.ft. chamber	4.0	1/4	Excelsior pack in 8 wooden crates.	120	3,856	817	436	78.81		
237	"	4.0	"	Fruit naked in 8 wooden crates.	120	3,856	78	20	97.98		
238	7.7 cu.ft. drum	4.0	"	Loose—no containers	60	1,928	0	0	100.0		
239	"	4.0	"	" " "	120	1,928	3	0	99.84		
240	10 cu.ft. chamber	4.0	"	Excelsior pack in 8 wooden crates.	120	3,825	166	43	95.66	96.6 100.0	0.4
241	"	4.0	"	8 wooden crates, fruit naked.	120	3,825	0	0	100.0	100.0 99.4	0.6

Table 5 (cont'd)

Expt. No.	Type of fumigator	Dosage mg/l	Dosage lbs./1000 ft.³	Method of Loading	No. of fruits	Estimated population	Survivors pupae	Survivors adults	Per cent mortality	Per cent mortality naked eggs	EDB recovered 2 hrs. mg/l
242	7.7 cu.ft. drum	4.0	1/4	Fruit loose-no container	60	1,913	0	0	100.0	100.0 100.0	---
243	"	4.0	"	"	120	3,825	0	0	100.0	100.0 100.0	---
244	10 cu.ft. chamber	1.0	1/16	8 wooden crates and excelsior pack.	120	3,825	1801	1047 (10)	52.92	98.3 46.9	0
245	"	1.0	"	Fruit naked in 8 wooden crates.	120	3,825	1598	807 (2)	58.22	94.4 87.8	0.1
246	7.7 cu.ft. drum	1.0	"	Fruit loose-no container	60	1,913	182	60	90.49	100.0 97.8	0.6
247	"	1.0	"	"	120	3,825	437	104(2)	88.57	99.4 100.0	0
248	10 cu.ft. chamber	2.0	1/8	8 wooden crates and excelsior pack.	120	132	0	0	100.0	12.96 5.88 9.41	---
249	"	2.0	"	Fruit naked in 8 wooden crates.	120	132	0	0	100.0	36.47 74.12 74.12	---
250	"	6.0	3/8	"	120	132	0	0	100.0	100.0 100.0 100.0	---
251	"	6.0	"	8 wooden crates and excelsior pack.	120	132	4	0	96.97	69.41 4.71 10.59	---
252	"	8.0	1/2	"	120	132	0	0	100.0	---	---
253	"	8.0	"	Fruit naked in 8 wooden crates.	120	132	0	0	100.0	---	---
254	"	3.0	3/16	8 wooden crates and excelsior pack.	120	958	29	6	96.97	94.96 52.96 43.0	0

Table 5 (cont'd)

Expt. No.	Type of fumigator	Dosage mg/l	Dosage lbs./1000 ft.^{3}	Method of Loading	No. of fruits	Estimated population	Survivors pupae	Survivors adults	Per cent mortality	Per cent mortality naked eggs	EDB recovered 2 hrs. mg/l.
255	10 cu.ft. chamber	3.0	3/16	Fruit naked in 8 wooden crates.	120	958	1	0	99.90	84.8 94.96 92.41	0
256	"	5.0	5/16	"	120	958	4	0	99.58	100.0 98.67 100.0	0.8
257	"	5.0	5/16	8 wooden crates and excelsior pack.	120	958	7	0	99.27	92.41 86.08 81.14	0.2
258	"	7.0	7/16	Fruit naked in 8 wooden crates.	120	958	0	0	100.0	88.67 94.96 85.74	1.0
259	"	7.0	"	8 wooden crates and excelsior pack.	120	958	0	0	100.0	98.67 100.0 100.0	1.2
260	"	6.0	3/8	"	120	549	0	0	100.0	0 0 93.7	0.2
261	"	6.0	"	Fruit naked in 8 wooden crates.	120	549	0	0	100.0	100.0 100.0 100.0	0.8
262	"	7.0	7/16	"	120	549	0	0	100.0	100.0 100.0 97.8	1.2
263	"	7.0	"	8 wooden crates and excelsior pack.	120	549	0	0	100.0	93.93 71.0 93.7	0.6
264) 265)	error in applying fumigant - volatilisation incomplete?										
266	10 cu.ft.	4.0	1/4	Fruit packed with cardboard separators in 8 sealed shipping cartons.	64	383	0	0	100.0	98.5 71.4	0

Table 5 (cont'd)

Expt. No.	Type of fumigator	Dosage mg/l	Dosage lbs./1000 ft.^{3}	Method of Loading	No. of fruits	Estimated population	Survivors pupae	Survivors adults	Per cent mortality	Per cent mortality naked eggs	EDB recovered 2 hrs. mg/l
267	10 cu. ft. chamber	4.0	1/4	Fruit wrapped individually in citrus tissue & packed in wooden excelsior in 8 sealed shipping cartons.	96	575	0	0	100.0	36.8 97.0	0
268	"	6.0	3/8	Same as 267	96	575	0	0	100.0	---	0.2
269	"	6.0	"	Same as 266	64	383	0	0	100.0	---	0
270	"	8.0	1/2	Same as 266	64	383	0	0	100.0	---	0.8
271	"	8.0	"	Same as 267	96	575	0	0	100.0	---	0.6
272	"	8.0	"	Same as 266	64	14	0	0	100.0	100.0 100.0	0.2
273	"	8.0	"	Same as 267	80	17	0	0	100.0	100.0 34.0	0
274	"	12.0	3/4	Same as 267	80	17	0	0	100.0	100.0 96.10	0.8
275	"	12.0	"	Same as 266	64	14	0	0	100.0	100.0 100.0	0.4
276	"	6.0	3/8	Same as 266	64	1,915	4	1	99.79	100.0 100.0	0.4
277	"	6.0	"	Same as 267	80	2,393	0	0	100.0	30.8 100.0	0.4
278	"	10.0	5/8	Same as 267	80	2,393	0	0	100.0	100.0 100.0	0.6
279	"	10.0	"	Same as 266	64	1,915	21	5	98.90	100.0 100.0	1.0
280	"	2.0	1/8	Same as 266	64	1,915	21	2	98.90	10.3 18.0	0
281	"	2.0	"	Same as 267	80	2,393	3	0	99.87	35.9 7.7	0

Table 5 (cont'd)

Expt. No.	Type of fumigator	Dosage mg/l	Dosage lbs./1000 ft.^{3}	Method of Loading	No. of fruits	Estimated population	Survivors pupae	Survivors adults	Per cent mortality	Per cent mortality naked eggs	EDB recovered 2 hrs. mg/l
282	10 cu. ft. chamber	4.0	1/4	Same as 267	80	2,378	0	0	100.0	88.2 64.5	0.4
283	"	4.0	"	Same as 266	64	1,904		6	99.68	97.4 94.7	0.1
284	"	8.0	1/2	Same as 266	64	1,904	0		100.0	100.0 100.0	0.3
285	"	8.0	"	Same as 267	80	2,380	0		100.0	100.0 100.0	0.8
286	"	12.0	3/4	Same as 267	80	2,380	0		100.0	3.3 42.8	0.6
287	"	12.0	"	Same as 266	64	1,904	0		100.0	100.0 100.0	0.8
Totals					5,547	114,521					

CONTROLS	No. of fruits	Estimated population	Emergence dor.	Emergence par.	
226-228	100	1,778	1086	1	0.0
229-231	110	5,533	2702	0	"
232-239	120	3,856	2752	1	"
240-247	120	3,825	2709	1	"
248-253	120	132	48	13	"
254-259	120	958	608	6	"
260-265	120	549	335	0	
266-271	85	509	216	2	
272-275	36	8	8	0	
276-281	54	1,616	1071	0	
282-287	54	1,607	1086	0	
Totals	1,039	20,371	12,621	28	

E.--Chemical Analysis of EDB during Fumigation (Balock and Swanholm): Chemical analyses following the method of Sinclair and Crandall were conducted during most of the tests with EDB. The recoveries after 2 hours are shown in the last column of table 5. Since most of the loss is attributed to sorption, the concentrations listed represent those which were present during most of the fumigation period since sorption is a rapid process. There is no definite correlation between EDB recovery and fruit fly mortality. In many instances no recovery of EDB chemically has been associated with complete fruit fly mortality in fruit and in other cases relatively high gas recoveries have been made in tests where survivors were recorded. Such survival might well reflect uneven gas diffusion throughout the chamber.

In an attempt to get a breakdown of the factors associated with sorption during fumigation, such as walls of the chamber, wooden crates, paper cartons, excelsior, and fruit, a series of tests was conducted to determine gas loss under the above conditions. The results of these tests are shown in table 6.

Table 6.--The amount of EDB sorbed by various materials during a 2-hour fumigation period at a dosage of 1/2 lb. per 1000 cu. ft. (8 mg./liter) in a 10 cu. ft. sheet metal chamber.

Load	Sorptive material	EDB recovered mg./liter	Sorption attributed to material mg./liter	Per cent
Empty chamber	chamber	3.8	4.2	53
8 wooden crates	crates	2.0	2.2	28
8 cardboard cartons + wood excelsior	cartons + excelsior	0.8	3.2	40
8 cardboard cartons + cardboard separators	cartons + separators	1.0	3.4	43
Above + 120 papayas	papayas	0.8	0.2	3

As may be seen from the above table, sorption is exceedingly high, especially on materials other than the products fumigated. In spite of this high sorption it is remarkable that EDB is still so highly effective in destroying fruit fly infestations. Figures 7 and 8 are presented to show the recovery of EDB from a dosage of 1/2 lb. per 1000 cu. ft. after 15 minutes and 2 hours from a 10 cu. ft. chamber loaded with 8 paper cartons of papayas.

Figure 7.--Recovery of EDB after 15 minutes from a 10 cu. ft. chamber loaded with papayas packed in 8 sealed cardboard cartons.

⊙ = Fruit packed with cardboard separators (8 fruits per carton).

× = Fruit wrapped in citrus tissue and packed in wood excelsior (10 to 12 fruits per carton).

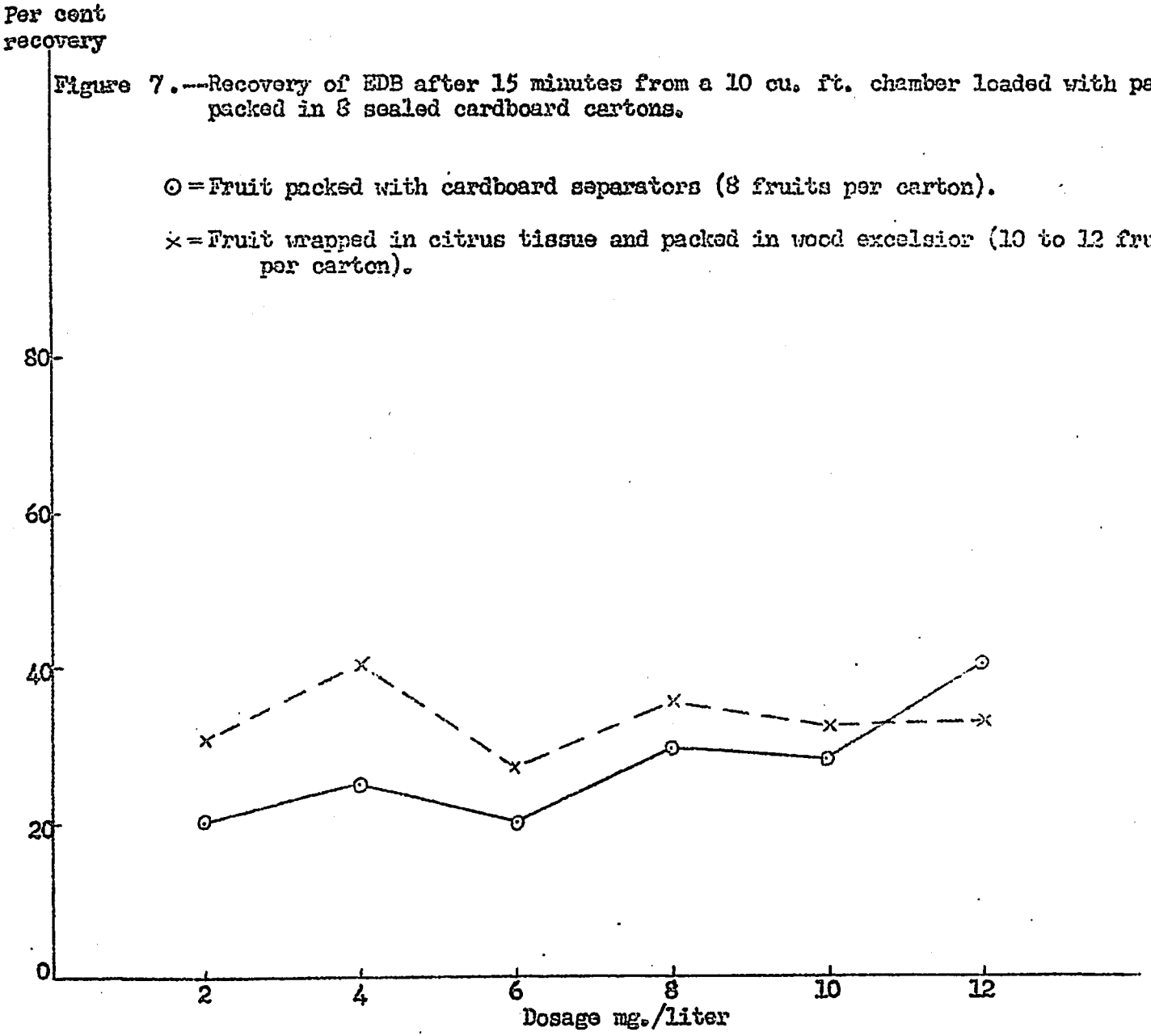
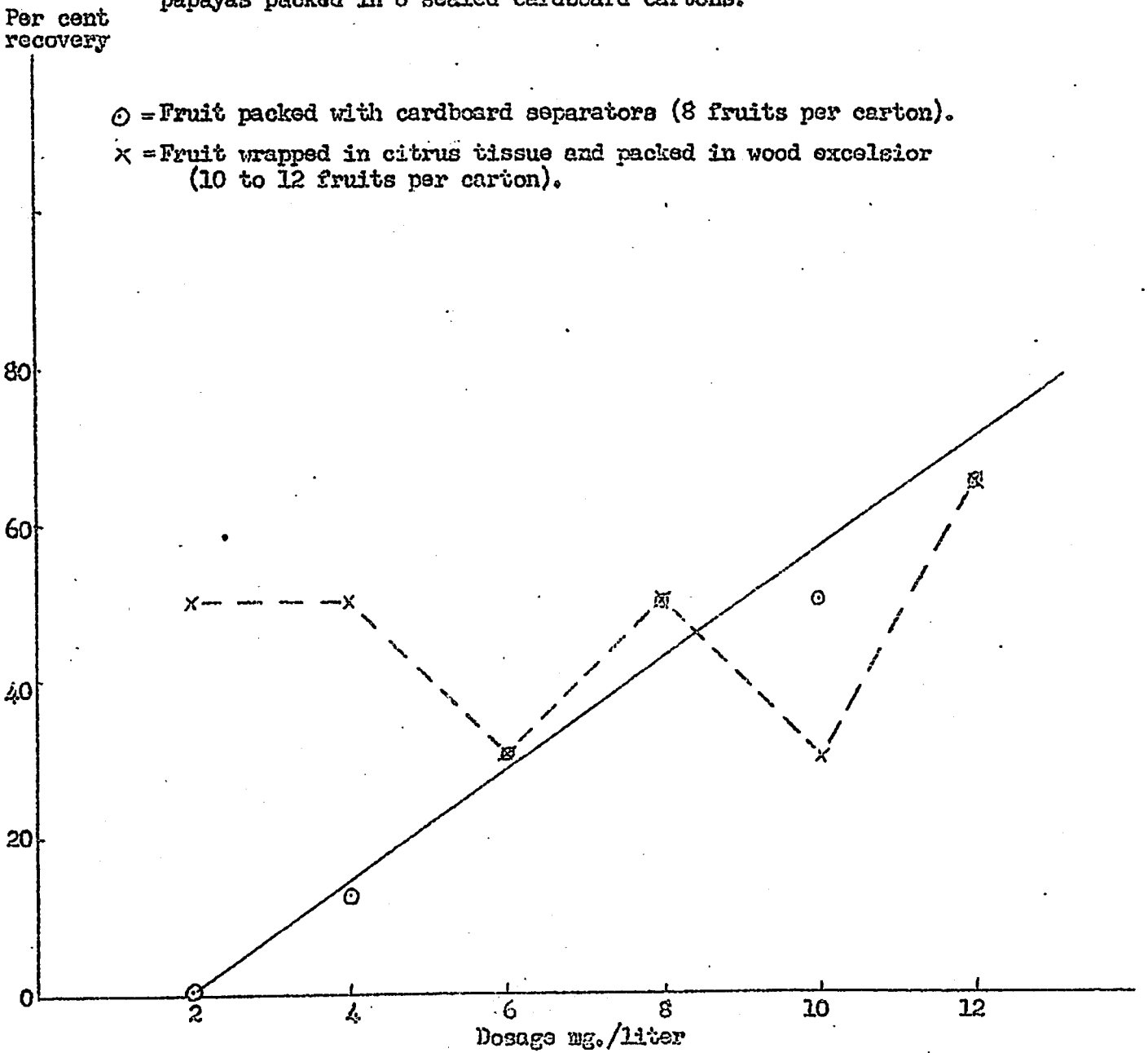


Figure 8.--Recovery of EDB after 2 hours from a 10 cu. ft. chamber loaded with papayas packed in 8 sealed cardboard cartons.



F.—Biological Measurements of EDB (Balock & Kozuma): In connection with many of the experiments conducted to determine the mortality of eggs and larvae of the oriental fruit fly in EDB-fumigated fruits, tests with naked eggs were included to find out whether such biological tests could be used for determining lethal dosages. As can be seen from the data in the second to the last column in table 5, the mortality of naked eggs closely parallels that in fruit under conditions where the fruit is fumigated loose in the chamber or naked in open wooden crates, but when fruit was fumigated packed in excelsior in wooden crates or sealed paper cartons the mortalities of naked eggs were generally lower than the mortalities of eggs and larvae in infested fruits. This is attributed to small amounts of EDB sorbed in fruit and packing material which may exert a post-fumigation effect. In these tests eggs were removed from sealed cartons 1 to 6 hours after fumigation whereas the fruits remained in the cartons for 24 hours after fumigation before they were removed and placed in holding boxes to determine survival.

G.—Ethylene Dibromide as a Fumigant for the Mediterranean Fruit Fly in Oranges: Seven experiments were conducted in this series (98-104) to determine a mortality line for the Mediterranean fruit fly in oranges fumigated with EDB. The scarcity of suitable oranges because of the shipping strike prevented more extensive testing.

Three of the tests were made with California Navels, and 4 with Valencias. The oranges were fumigated in three 7.7 cu. ft. steel drums and in two 10 cu. ft. galvanized sheet metal chambers. Fruits were exposed as received to Medflies in cages for 2 1/2 to 4 hours and then held 6 to 8 days before fumigation to permit some larval development.

Infestation in Valencias was extremely low; 730 check fruits developed an infestation of only 173 larvae. Results with Navels were considerably better—564 larvae out of 324 fruits. This might indicate a difference in susceptibility of the two varieties. It is not known how long the fruits were in storage. The Valencias originated from the Orosi Foothills Citrus Association, Orosi, California. Origin of the Navels is not known.

An examination of the Valencias under a low power binocular showed fairly heavy egg deposition in all of the fruits examined, but in many cases the oviposition sites were sealed off by callousing. In most cases larvae appeared to have died shortly after hatching but in some cases larval development had advanced before they were killed. A check on viability of 900 eggs from the same flies indicated 62% fertile eggs. In test 105, the oranges were broken open at the second sifting about 16 days after they were infested. This was associated with a higher larval recovery than in previous tests when fruits were not broken open.

The dosages tested were 1/8, 1/4, 3/8, and 1/2 lb./1000 cu. ft. for 2 hours at 70° F. Survivors were recorded at the 1/4 lb. dosage only. The data are shown in table 7.

Table 7.--The mortality of the Mediterranean fruit fly in oranges infested by caged flies and fumigated with EDB at dosages of 1/8 to 1/2 lb./1000 cu. ft. for 2 hours at 70° F.

Expt. no.	Chamber	Dosage mg./l.	No. of Oranges	Est. pop.	Survivors		% Mort. 1/	% Mort. Naked eggs 2/
					Pup.	Adults		
98	7.7 cu.ft.	4.0	325(77 lbs.) 3/	559	35	29	93.7	T---100.0 B--- 97.1
99	"	8.0	317(74 ") 3/	546	0		100.0	T---100.0 B---100.0
100	"	8.0	324(76 ") 3/	559	0		100.0	T---100.0 B---100.0
101	10 cu.ft.	6.0	482(146 ") 4/	0	0		---	100.0 5/
102	"	6.0	482(147 ") 4/	0	0		---	100.0 5/
103	"	2.0	498(139 ") 4/	36	0		100.0	---
104	"	4.0	498(139 ") 4/	36	0		100.0	---
105	"	8.0	480(133 ") 4/	310	0		100.0	---
Totals fumigated			3406(931 ")	2046				
98-100	Checks		324(75 lbs.)	564	564	400		
101-102	"		241(75 ")	0	0	0		
103-104	"		249(70 ")	18	18	15		
105	"		240(63 ")	155	155	52		
Total checks			1054(283 ")	737				

1/ Based on surviving pupae.
2/ One hundred eggs (24 hours old) per test--on wet blotting paper in open Petri dishes at top (T) and bottom (B) of chamber.
3/ One crate.
4/ Two crates.
5/ Four hundred eggs--200 inside top and bottom crates, and 200 outside crates at top and bottom of chamber.

H.--Tolerance Studies: Four tests were conducted to determine tolerance of papayas and pineapples to EDB when fumigated in sealed cardboard cartons. Ratoon and plant crop pineapples, mature green to 1/4-ripe, were packed in cardboard cartons, 4 ratoon fruits per carton or 3 plant crop fruits per carton (6-1/2" x 11-1/2" x 16"). The fruits were separated from each other by cardboard sections. Four cartons containing plant crop fruits and 4 containing ratoon fruits were fumigated in the 10 cu. ft. chamber at the same time at dosages of 3/4 lb. and 1.0 lb./1000 cu. ft. for 2 hours at 70° F. Similar tests were conducted with mature green and 1/4-ripe papayas which were individually wrapped in citrus tissue and packed in wood excelsior--8 fruits per carton. The fruits were stored at 55° F. for 6 days after fumigation without removal from the cartons. They were then removed to room temperature and the pineapples were sampled daily for 6 days, while the papayas were sampled as they ripened. Akamine of the Hawaii Agricultural Experiment Station reported that he could detect no differences in appearance or flavor between treated and control fruits.

Line Projects I-o-5-5 and I-o-5-6 INACTIVE.

Line Project I-o-5-7. Investigations to Determine Infestation Indices in Exportable Hawaiian Fruits and Vegetables. (Balock and Kozuma)

Twenty-three lots of fruits and vegetables were held during this quarter to determine the degree of fruit fly infestation. No infestations were recorded in any of the dorsalis hosts--avocado, Cavendish banana, papaya, or pineapple. Infestation by cucurbitae was, in general, above the mean for most of the cucurbitae hosts.

The data for the current quarter together with cumulative totals are shown in table 8.

Table 8.--Fruit fly infestation in exportable fruits and vegetables. The totals of Column 1 are the cumulative totals of this quarter plus previous quarters.

Fruit or vegetable	Variety	Degree of maturity	Collection no.	1952 date	Source	Fruit		Larvae		Emergence 1/				
						No.	Wt. lbs.	Total	Per lb.	dor.	cuc.	O.p.	O.o.	Other
Avocado	Seedling	mature green	46	5/14	Y.Fukumaga Hilo	20	30	0	0					
TOTALS						1777	1725	117	.068	80	0	0	0	0
Banana	Cavendish	"	8	5/13	K. Mashita Maunawili	140	31	0	0					
TOTALS						790	346	0	0					
Banana	Cavendish	1/4 ripe	3	5/13	"	140	34	0	0					
TOTALS						381	334	0	0					
Bell Pepper	Cal. Wonder		33	4/29	K. Higa Waikane	165	31	82	2.645		68			
TOTALS						5106	1243	352	0.283	23	231	0	0	0
Bitter Melon														
TOTALS			7			820	275	1601	5.822	0	1123	0	0	0
Cucumber	?		26	5/13	Horinouchi Waimanalo	45	55	0	0					
TOTALS						2731	2454	3739	1.524	0	2555	0	0	0
Egg Plant	Round		13	5/14	S. Sawa Ewa	40	40	0	0					
TOTALS						340	307	0	0					
Mango	Hadon													
TOTALS		mature green	4			13	11	17	1.55	14	0	0	0	
		1/4 ripe	4			19	15	119	7.93	77	0	0	0	
		1/2 ripe	5			13	11	94	8.55	71	0	0	0	

Table 8 (cont'd)

Fruit or vegetable	Variety	Degree of maturity	Collection no.	1952 date	Source	Fruit No.	Fruit Wt. lbs.	Larvae Total	Larvae Per lb.	Emergence[1] dor.	cuc.	O.p.	O.c.	Other
Papaya	Solo	mature green	60	3/20	Kaneohe	50	70	0	0					
			61	4/8	Kahuluu	50	56	0	0					
			62	5/29	"	50	45	0	0					
TOTALS						5078	7545	74	0.009	53	0	0	0	0
Papaya	"	1/4 ripe	41	3/20	Kaneohe	50	60	0	0					
			42	4/8	Kahuluu	50	57	0	0					
			43	5/29	"	50	50	0	0					
TOTALS						2339	2982	129	0.043	93	0	0	0	0
Papaya	"	1/2 ripe	31	3/20	Kaneohe	50	60	0	0					
			32	4/8	Kahuluu	50	54	0	0					
			33	5/29	"	50	50	0	0					
TOTALS						1640	2145	3686	0.785	766	10	6	77	0
Pineapple[2]	Smooth Cayenne	1/4-3/4 ripe Plant	79	4/15	H.P.-Waipio (4282)	30	127							
			80	4/15	H.P.-Kunia (4307)	30	43							
			81	5/8	H.P.-Waipio (4282)	20	82							
			82	5/8	H.P.-Kunia (4307)	20	32							
TOTALS						1664	5432	2	0.00037	1	0	0	0	0
Snap beans	Lualualei		17	5/14	Kailua		20	0	0					
TOTALS							433	1804		0	1431	0	0	0

Table 8 (cont'd)

Fruit or vegetable	Variety	Degree of maturity	Collection no.	1952 date	Source	Fruit		Larvae		Emergence 1/				
						No.	Wt. lbs.	Total	Per lb.	dor.	cuc.	O.p.	O.o.	Other
Tomato	?	mature green	27	4/22	Waikane	180	75	137	1.89		109			
TOTALS						4138	1526	1000	0.655	27	651	0	0	0
Tomato	?	1/4 ripe	27	4/22	"	270	110	694	6.309		559	0	0	0
TOTALS						4017	1545	1750	1.399	3	1269	0	0	0
Zucchini squash			9	5/13	Hilo	70	33	351	10.6		318	0	0	0
TOTALS						401	246	999	4.028	0	837	0	0	0

1/ Dor.=dorsalis; cuc.=cucurbitae; O.p.=Opius persulcatus; O.o.=Opius oophilus.
2/ Pineapples shelled before placing in holding boxes; all others held entire.

Factors Affecting the Keeping Quality of Cut Flowers, Foliages, Ornamentals, Fruits, and Vegetables in Relation to Quarantine Sterilization Requirements for Export. (Ernest K. Akamine, H.A.E.S.)

The following is a resume of the studies conducted by the Department of Plant Physiology, University of Hawaii Agricultural Experiment Station, during the period ending June 30, 1952, on the tolerance of the various commodities to treatments required for destroying the oriental fruit fly. Certain treatment, storage, and personnel facilities of Grant No. 5X of the Industrial Research Advisory Council, Territory of Hawaii, were employed in these studies.

Banana (Chinese)

Further tests were conducted to determine the cause of the difference in tolerance to ethylene dibromide in Chinese bananas harvested from different localities. That storing the non-tolerant bananas at 55° F. prior to fumigation increases somewhat the tolerance of the fruit to the gas was again demonstrated in other tests (tests 58, 59, 60, 61). When bananas which were allowed to mature in a wrap in the field were stored at 55° F. for 6 days before fumigating with ethylene dibromide, they were not injured by the gas treatment (test 62). Dipping the bananas in dilute sulfuric acid and sodium hydroxide solutions for short periods before fumigating did not alter the degree of tolerance to the fumigant (tests 63, 64).

Papaya

Effect of the hot water treatment on the control of anthracnose rot was described in the previous quarterly report. Since then the data have been compiled in a manuscript which was submitted for publication.

Papayas treated with ethylene dibromide at a dosage of 3/4 pound per 1000 cubic feet for 3 hours at 70° F. in a 3/4-loaded chamber tolerated the treatment (fruit fly laboratory test 138; test 109).

Papayas (mature green and 1/4 ripe) treated in commercial sealed cartons with ethylene dibromide at dosages of 3/4 and 1 pound per 1000 cubic feet for 2 hours at 70° F. tolerated the fumigant (Fruit fly laboratory tests 38, 39; test 110).

Avocado

Several new varieties were added to the long list of avocados already investigated for tolerance to ethylene dibromide and for determination of eating and keeping qualities. Testing of other varieties as they become available will be continued.

Pineapple

Plant and ratoon fruits were wrapped in corrugated paper sleeves and packed in 36 pineapple crates (Fruit fly laboratory tests 139, 140; test 58).

These were fumigated in a 3/4-loaded chamber with ethylene dibromide at a dosage of 3/4 pound per 1000 cubic feet for 3 hours at 70° F. These fruits when subsequently stored at 45° F. and at room temperature for various periods showed no gas injury.

Pineapples (mature green and 1/4 ripe plant and ratoon crop fruits) were sealed in paper cartons with cardboard partitions (3 or 4 fruits to each carton). These were fumigated with ethylene dibromide at dosages of 3/4 and 1 pound per 1000 cubic feet for 2 hours at 70° F. After fumigation they were stored first at 45° F. for 6 days, then at room temperature and sampled daily for 6 days. All treated fruits were not any different from the controls (Fruit fly laboratory tests 40, 41, 42, 43; test 59).

Watermelon

To satisfy an inquiry as to the effect of ethylene dibromide on watermelons, fruits from three localities were treated with this gas at a dosage of 1/2 pound per 1000 cubic feet for 2 hours at 70° F. All the watermelons tolerated the treatment (test 1).